BSE Surveillance Methods for OIE Code Recommendation

When conducting surveillance for the purpose of detecting disease, one is typically trying to detect disease at a very low level. However, detection of very low levels of disease using a simple random sampling scheme rapidly necessitates extremely large sample sizes. Surveillance in this situation is much more efficiently achieved through targeted sampling of the sub-populations of cattle that are most likely to display disease and in which the disease is most likely to be detected.

Targeted sampling for BSE surveillance should focus on two factors that have been shown to be of risk for BSE: clinical presentation and age. For the purpose of disease detection, it is most efficient to collect as many samples as possible from the surveillance stream which has the greatest likelihood of having the disease (i.e. highest prevalence), that being cattle displaying clinical signs consistent with BSE. Since it is likely that a country can not meet their needed number of samples from this surveillance stream alone, additional samples should be taken from the surveillance streams with the next highest likelihood for finding BSE, that being animals that are non-ambulatory or condemned ante-mortem at slaughter (casualty or emergency slaughter), followed by cattle which are found dead (fallen stock). Of lowest priority are healthy slaughter cattle.

Proposed Options For BSE Surveillance Methods

Following are three options for methods to determine the level of BSE surveillance for a country. A country can choose the most appropriate method based on their level of analytical expertise and data available. When adequate data are available, a country may use the BSurvE model to determine the confidence in their surveillance efforts (Option 1). However, if detailed demographic data are not available, a country can still make use of the BSurvE model by estimating this information using the provided tables (Option 2). Another choice is to rely entirely on the provided tables to determine the level of surveillance desired and to assign value to the information gained from the country's collected surveillance samples (Option 3).

All three options make use of assigning "points" based on the inputs and likelihood of detecting infected cattle in each surveillance stream. The methods used assign points which normalize the value of information received from different samples. For example, a sample from the highest risk animal (5-year old cow that is a clinical suspect for BSE) is "worth" more points than a sample from a healthy animal of any age because the 5-year old is much more likely to test positive if BSE is present, and therefore provides more valuable information. Both the surveillance stream from which the animal is collected (i.e. clinical signs being exhibited by the animal) and the age of the animal sampled impact the number of points it is worth. A combination of point calculations result in a final score which can be compared to a target number of points for a country based upon their desired level of confidence and design prevalence.

Risk mitigations such as feed bans, rendering practices, SRM removal, and import practices must all be considered as factors in predicting the likelihood that the country's status will remain at the level determined by surveillance testing. The efficacy of such measures intended to prevent exposure and spread of BSE must be evaluated separately from sample testing, as described in the OIE code, and are not included in the surveillance options described below.

<u>Option 1: BSurvE Model</u>
The BSurvE model is a useful tool for countries that have good quality data or reliable estimates of the age distribution of their adult cattle population and the number of cattle tested for BSE stratified by age and by surveillance stream. Additional inputs required by the model are estimates of the proportion of uninfected animals that leave each surveillance stream for each age and the proportion of infected animals showing clinical signs that exit each surveillance stream for each age. The output of the model describes the amount of testing needed to achieve a target confidence in the level of BSE prevalence and provides point values for samples tested.

Before the BSurvE model can be recommended as a tool for evaluating BSE surveillance, it must go through a formal peer review process. This process should include further review by statisticians and by analytical experts knowledgeable regarding BSE epidemiology.

<u>Option 2: BSurvE Model With Provided Input</u>
This option allows a country to use the BSurvE model by making use of provided disease parameter estimates when the country does not have detailed demographic data available. Details regarding the derivation of the parameter estimates are in Appendix 2.

Step 1
Use Table 1 (all tables are in Appendix 1) to identify the production intensity of a country's cattle population based on local epidemiological knowledge, mean cattle age, and age that 95 percent of the adult cattle population is below (95^{th} percentile).

Example: Country U has moderately conservative management practices with many small herds, but some herds of larger size. Many animals will stay in the herd until they are about 7 years old. Based on the knowledge of their cattle population and using Table 1, Country U determines itself to have a moderate production intensity.

Step 2
Based on the production intensity determined in Step 1, identify the corresponding age distribution using Table 2. Age distribution of a nation's cattle population is an important risk factor for BSE surveillance and therefore significantly influences the assessment of BSE surveillance.

Example: Country U estimates its adult cattle population's age distribution to follow the middle column of Table 2. These proportions are entered into the BSurvE input data tables.

Step 3

Use the age distribution determined from Step 2, the national adult cattle population size, and surveillance data as inputs to the BSurvE model. A nation's adult cattle population size may be estimated or may be set at one million animals since within the BSurvE model one million is considered to be the point where sample size does not further increase with population size. The output of the model will describe the amount of testing needed to achieve a target confidence in the level of BSE prevalence and provide point values for samples tested.

<u>Option 3: Select Point Target and Values of Samples from Provided Tables</u>

In this option, only the provided tables, knowledge of the country's husbandry practices, size of the national adult cattle population, and approximate cattle population age are needed to determine a desired surveillance point target and the point values of surveillance samples collected. Explanation of the derivation of the tables is in Appendix 2.

Step 1

Use Table 1 to identify the production intensity of the country's livestock population based on local epidemiological knowledge, mean cattle age, and age that 95 percent of the adult cattle population is below (95^{th} percentile).

Example: Country V has comparatively conservative management practices, tending to have small herd sizes and keep animals in the herd until they are over 10 years old. Based on the knowledge of their cattle population and using Table 1, Country V determines itself to have low production intensity.

Step 2

The desired surveillance point target is selected from Table 3, which shows target points for populations of different sizes. A nation's adult cattle population size may be estimated or may be set at one million animals as one million is considered to be the point where sample size does not further increase with population size. The choice of target depends on the degree of certainty that a country wishes to know about their BSE prevalence.

Example: Country V has never identified BSE within their cattle population and has an adult cattle population of approximately 400,000. They would like to make sure they do not have BSE in their adult cattle population at a maximum prevalence of 1 case per 100,000. Using Table 3, Country V must acquire 119,829 points to be 95% confident that 1 in 100,000 is the maximum possible prevalence of BSE in their adult cattle population.

Step 3

Table 5 can be used to determine the point values of surveillance samples collected. Because precise aging of animals that are sampled may not be available, Table 5 combines point values from ages into categorical estimates for a young adult, middle adult, older adult, or aged animal. The point estimates for each category were determined as an average over each of the ages comprising the group. The age groups were selected based on the likelihood of manifesting signs of BSE according to scientific knowledge of the incubation of the BSE prion[1] and the European BSE experience.

The distribution of samples can be made up from any combination of samples from the various surveillance streams and ages, and thus any combination of sample point values. Countries should design their surveillance strategy to ensure that samples are representative of the national herd and include consideration of demographic factors such as production type, geographic location, and culturally unique husbandry practices. The total points for samples may be accumulated over several years to achieve the target number of points determined in Step 2.

Example: At the end of three years, based on the values of samples (Table 5) and the production intensity of their country (estimated from Table 1), Country V determines that they have accumulated enough samples to reach 128,000 points. They have had no new cases of BSE and demonstrate that the samples are representative of all geographical and culturally unique subpopulations. They also document that effective mitigations (based on OIE standards) are in place. Since 128,000 is greater than their point target, they then state with 95% confidence that “BSE must not be present in country V at prevalence higher than 1 case per 100,000 adult cattle”.

Surveillance In Countries With BSE

For countries that have determined that BSE exists within their cattle population, the goal of surveillance shifts from one of detection to one of monitoring the extent and evolution of the disease, and monitoring the effectiveness of control measures such as feed bans and SRM removal policies. Using the BSurvE model will allow a country to calculate BSE prevalence, with an upper confidence limit, if the country has adequate availability of population and surveillance data as previously discussed. For a country that uses Option 3 and has identified at least one case of BSE, Table 4 should be used in place of Table 3 to determine the point target. Otherwise, the method is the same as described above. Options 1 and 2 allow estimation of prevalence when one or more cases have been discovered. Option 3 does not allow a country to calculate BSE prevalence when cases exist, however, it can be used to determine when the maximum prevalence falls below the selected prevalence level.

Maintenance Surveillance

If BSE is determined to not be present or be at very low levels and food/feed safety mitigations are effectively in place, it is extremely likely that disease prevalence would continue to decline.

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[1] **Evaluation of the Potential for Bovine Spongiform Encephalopathy in the United States. Appendix 1, 2001.** Joshua T. Cohen, Keith Duggar, George M. Gray, Silvia Kreindel
Harvard Center for Risk Analysis, Harvard School of Public Health

Confidence in the efficacy of mitigations and reliability of control point monitoring directly influence the needed amount of ongoing surveillance sampling in the cattle population. A suggestion made by the authors of the BSurvE model is that sampling might be reduced to 5% of the target value based on a renewal of information rate equal to one year divided by a maximum bovine lifespan of 20 years (1/20 = 5%). By the same reasoning, but in more conservative fashion, since the vast majority of cattle demonstrate clinical BSE before 8 years of age, an effective disease lifespan of 8 years might drive a renewal rate of 1/8 of the target points per year. Regardless of the approach taken for maintenance sampling, it is clear that continued testing of large numbers of animals has no scientific basis, and provides minimal if any additional information.

Appendix 1

Tables

Table 1. Estimating production intensity

Production	Mean age	95th age percentile
Intensive	4	Under 7.5 years
Moderate	5	Under 10 years
Low intensity	6	Under 13 years

Table 2. Age distribution of adult cattle population

	*PRODUCTION INTENSITY		
Age	**High**	**Moderate**	**Low**
2	0.295	0.22	0.16
3	0.255	0.21	0.17
4	0.18	0.17	0.15
5	0.115	0.13	0.12
6	0.07	0.09	0.1
7	0.04	0.06	0.075
8	0.02	0.04	0.06
9	0.015	0.03	0.055
10	0.005	0.02	0.035
11	0.003	0.01	0.03
12	0.001	0.01	0.025
13	0.001	0.01	0.02

*distribution is represented as a proportion of the adult population.

Table 3. Point targets for several different adult cattle population sizes in a country which has not identified any BSE cases

Target points for country with 0 cases, 95% confidence		
Adult Cattle Population Size	***DP 1/1,000,000**	**DP 1/100,000**
> 1,000,000	2,995,730	299,573
800,000	2,396,584	239,658
600,000	1,797,438	179,744
400,000	1,198,292	119,829
200,000	599,146	59,915
100,000	299,573	29,957
50,000	149,787	14,979

*DP is the maximum possible prevalence or “design prevalence”

Table 4. Point targets for several different adult cattle population sizes in a country that has identified cases of BSE

Target points	**1 case 95% confidence**		**2 cases 95% confidence**	
Adult Cattle Population Size	**DP 1/1,000,000**	**DP 1/100,000**	**DP 1/1,000,000**	**DP 1/100,000**
> 1,000,000	4,743,870	474,387	6,295,795	629,580
800,000	3,795,096	379,510	5,036,636	503,664
600,000	2,846,322	284,632	3,777,477	377,748
400,000	1,897,548	189,755	2,518,318	251,832
200,000	948,774	94,877	1,259,159	125,916
100,000	474,387	47,439	629,579	62,958
50,000	237,193	23,719	314,789	31,479

*DP is the maximum possible prevalence or "design prevalence"

Table 5. Surveillance point values for samples collected from animals in the given surveillance stream and production intensity category

Production intensity	**Surveillance Stream**			
	Healthy slaughter	**Fallen stock**	**Casualty slaughter**	**Clinical suspect**
Age > 2 years and < 4 years (young adult)				
high	0.1	0.2	0.4	258
moderate	0.1	0.4	0.6	418
low	0.1	0.6	1.0	723
Age > 4 years and < 7 years (middle adult)				
high	0.2	0.9	1.6	748
moderate	0.2	1.0	1.9	887
low	0.2	1.4	2.7	1282
Age > 7 years and < 9 years (older adult)				
high	0.1	0.4	0.7	216
moderate	0.1	0.4	0.8	264
low	0.1	0.9	1.8	592
Age > 9 years (aged)				
high	0.0	0.1	0.2	44
moderate	0.0	0.1	0.2	36
low	0.0	0.1	0.2	39

Appendix 2

Using BSurvE as a surveillance tool with incomplete data.

BSurvE is a useful analytic tool for epidemiologists who are developing BSE surveillance strategies. However, because it is a data driven model, some countries with incomplete livestock data or minimal resources may find it of limited use. The following discussion provides guidelines for estimating inputs for the model through the use of simplified parameters. It also provides an output table of surveillance point values derived from the BSurvE model using the estimated age distribution parameters. This would allow an epidemiologist from a country with limited data or resources to easily calculate a BSE surveillance target.

1. **Unknown population size.**

Population size is an important parameter for the model although livestock populations greater than one million have been treated as having "infinite" population size. This concept describes sample size estimates that increase more and more slowly as the population size rises until the sample size plateaus with further increases in population. This allows a country with an unknown livestock population to estimate their total as 1,000,000 animals without effect on the model's outcome other than requiring a more conservative sample size than would be needed if exact data for a smaller population size were available.

2. **Modeling age distribution.**

The age distribution of the livestock population is an essential input to BSurvE as age has been shown to be a significant risk factor for detection of BSE. However, exact data may not be available for all countries. These data may be estimated with information gained from knowledge of animal husbandry, estimated mean age, and an estimate for age of the 95th percentile of the population. The simplified parameters may then be used to model an appropriate age distribution curve.

The age distribution of livestock in any country will differ by the intensity of production and management of the animals. For example, most dairy cattle in the United States are managed for maximum milk production and have a relatively short lifespan in the milking herd. Alternatively, countries with smaller herds and more conservative management practices may keep cattle in the herd until they are considerably older. Similarly, beef cattle in the US tend to remain in production significantly longer than high intensity production dairy herds. In spite of these differences, all national herds will be similar in that the highest proportion of animals are in the younger age groups and natural attrition and culling will cause a fairly smooth decline in the numbers of animals with each successive age increment. The rate of decline depends on husbandry factors such as disease management and the demands for production of meat or milk.

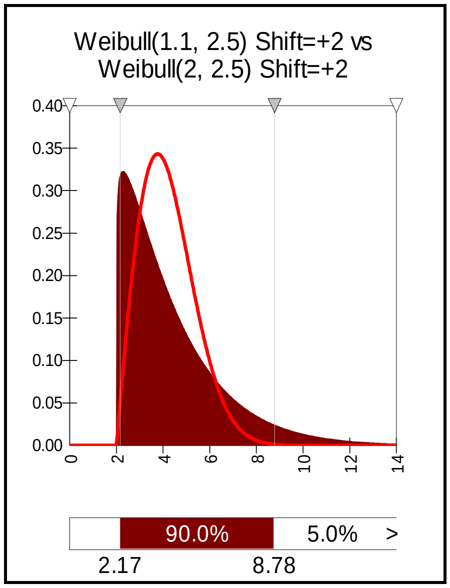
This aging and ultimate failure of animals is similar in nature to the aging and failure of a machine or machine component. The engineering field of Reliability Analysis is well defined and routinely utilizes mathematical processes to predict the lifespan and failure rate of mechanical components. Tools used in Reliability Analysis may be similarly applied to the aging and failure of production in animal populations such as cattle where failure is defined as exiting from the herd through death or culling.

The most logical function to describe this sort of aging is the density function of the Weibull distribution which is primarily used to model failure of machine components where the rate of failure is not constant across time steps. Likewise, cattle can be expected to "fail" or exit from a herd at any age but will be more likely to exit as their age increases. In other words, a seven year old cow is more likely to die or be culled than a six year old. The six year old is more likely to exit than the five year old, and so forth.

Since the Weibull distribution appears to be a logical choice to describe cattle aging, appropriateness of its use was confirmed by comparing data from dairy records from an eastern US milk shed, a western milk shed, beef cattle in the US, and to European data used in a BSurvE workshop[2]. In each case the data were fit with the Palisade Corporation software, @ Risk version 4.5 professional, giving a goodness of fit test statistic less than 0.001 for all populations.

A Weibull distribution is described by three parameters which define its shape, scale, and location. Figure 1 demonstrates the difference in α=1.1 and α=2.1 for the shape parameter, which also helps define the approximate peak (mode) of the distribution. For cattle, an age between two and three years is generally the time when milk production or calving begins and correlates to an alpha of 1.1 to 1.3.

Figure 1. The outlined distribution demonstrates a change from 1.1. to 2.1 in the shape parameter for the Weibull distribution.



Increasing the scale parameter (β) stretches the curve to the right on the X-axis (age in years) as would be expected in a population of lower production and older aged animals. Table 1 demonstrates the relationship between Beta value, mean age, and upper 95th percentile for cattle populations with alpha equal to 1.2.

The "shift" parameter defines the starting point for the distribution. The shift for BSE surveillance is approximately two years because the disease appears to be undetectable in younger animals given current testing methodologies.

3. Defining intensity of production.

High intensity livestock production is generally seen in the dairy industry in developed countries where each animal is expected to produce a maximum amount of milk over a relatively short

[2] Workshop in Woking England, June 2004. The authors of the BSurvE model (John Wilesmith, Roger Morris, and Rob Cannon) provided information about the model as well as sample data sets. The source country of the data remains anonymous.

lifespan. Herds are usually large and may often have several thousand animals that are fed high concentrate rations. Cattle will enter the adult production herd between two and three years of age and may peak then decline in productivity by four to six years of age. While there will inevitably be some proportion of low production animals, the large number of high production animals will result in a mean age for herds of about four to four and a half years. Likewise, there will be older cattle in the population, but the 95th percentile will be relatively low at about seven and a half to eight years of age.

Moderate intensity production will result in fewer large herds with the majority being medium to small sized and may have less than a hundred animals. Cattle will remain in the herd longer and the mean age of the national herd will be at about five to five and half years of age. There will also be a larger proportion of older cattle with the 95th percentile for upper aged cattle at about ten years.

Low intensity production will include many family farms and dairies with a few to a few dozen animals. They will not likely receive exceptionally high energy rations and will remain in the herd for a comparatively long time. Consequently, the mean age of the population will be about six to six and half years and the 95th percentile of aged cows will be at thirteen or more years.

Interestingly, the model for beef cattle is similar to the model for moderate and low intensity dairy herds. Breeding beef cattle typically stay in herds as long as they produce calves and the national herd is likely to have a mean age of five to six years. The 95th percentile will probably be above twelve.

4. Application of the Weibull model to determine age distribution, BSE surveillance point targets, and BSE surveillance point values.

Application of the Weibull distribution model to a cattle population provides a means to estimate the age distribution from simple parameters such as type of production, average age, and estimated number of very old cattle. Using a Weibull distribution model, Tables 1 and 2 were created.

Figure 2 demonstrates "point targets" for scenarios where a country has 0, 1, 2, or 3 cases of BSE and a cattle population of one million or greater (in the BSurvE model, one million is considered to be the point where sample size does not further increase with population size). These tables indicate the target number of points needed to attain various confidence levels that the prevalence of BSE is below the indicated prevalence and were generated with the BSurvE model.

BSurvE calculates target points needed to achieve confidence in the chosen design prevalence. Table 3 shows a summary table of target points for populations of different sizes with 0, 1, or 2 cases generated from the BSurvE model. Targets for countries with smaller cattle populations are reduced proportionately from a target using a population of one million as a reference point. This results in a country having a point target which is proportional to its cattle population size.

The choice of target depends on the degree of certainty that a country wishes to know about their BSE prevalence and is then compared to the number of points assigned to the samples collected. Tables 4, 5, and 6 are tables of point values for surveillance samples collected from the four surveillance streams (healthy slaughter, fallen stock, casualty slaughter, and clinical suspect) for the three levels of production intensity. They were generated with the BSurvE model using the age distribution data in Table 2 for the three levels of production intensity. The total points for samples may be accumulated over several years to achieve a target value.

Table 1, Appendix 2. Estimating the production intensity parameter (β) from age of population and α =1.2.

Production	Beta parameter	Mean age	95th percentile
Intensive	2.2	4	Under 7.5 years
Moderate	3.2	5	Under 10 years
Low intensity	4.3	6	Under 13 years

Table 2, Appendix 2. Age distribution table.

Proportion of adult population for each age from Weibull distribution model.

	PRODUCTION INTENSITY		
AGE	HIGH	MODERATE	LOW
2	0.295	0.22	0.16
3	0.255	0.21	0.17
4	0.18	0.17	0.15
5	0.115	0.13	0.12
6	0.07	0.09	0.1
7	0.04	0.06	0.075
8	0.02	0.04	0.06
9	0.015	0.03	0.055
10	0.005	0.02	0.035
11	0.003	0.01	0.03
12	0.001	0.01	0.025
13	0.001	0.01	0.02

Figure 2, Appendix 2. Target points for population of one million and 0, 1, 2, or 3 cases

Table 46. Number of points necessary (with no further positives being detected) to attain the required confidence that prevalence (cases per 10 000) is below the adjusted prevalence for countries that have identified X number of BSE cases in animals born after the starting point[a].

Population size 1000000
Number of cases detected (X) 0

Prevalence	Adjusted prevalence[b]	Required confidence level 90.0%	95.0%	97.5%	99.0%
0.0025	0.0025	9210344	11982920	14755497	18420687
0.0050	0.0050	4605172	5991460	7377748	9210344
0.0075	0.0075	3070115	3994307	4918499	6140229
0.0100	0.0100	2302586	2995730	3688874	4605172
0.0125	0.0125	1842069	2396584	2951099	3684137
0.0150	0.0150	1535057	1997153	2459249	3070115
0.0175	0.0175	1315763	1711846	2107928	2631527
0.0200	0.0200	1151293	1497865	1844437	2302586
0.0225	0.0225	1023372	1331436	1639500	2046743
0.0250	0.0250	921034	1198292	1475550	1842069

[a] Note that the initial value of X is the number of cases found in animals born after the starting period. Only animals born after the starting period would contribute points. If any further positives born after the start date were found, X, and consequently the testing requirement, would be increased.
[b] Prevalence is adjusted according to population size. For a population of one million animals or more, prevalence is per 10 000 animals. For smaller populations, the adjusted prevalence is calculated from the number of infected animals that would be in a population of 1 million.

Population size 1000000
Number of cases detected (X) 1

Prevalence	Adjusted prevalence[b]	Required confidence level 90.0%	95.0%	97.5%	99.0%
0.0025	0.0025	15558871	18975479	22286549	26553462
0.0050	0.0050	7779436	9487740	11143275	13276731
0.0075	0.0075	5186290	6325160	7428850	8851154
0.0100	0.0100	3889718	4743870	5571637	6638365
0.0125	0.0125	3111774	3795096	4457310	5310692
0.0150	0.0150	2593145	3162580	3714425	4425577
0.0175	0.0175	2222696	2710783	3183793	3793352
0.0200	0.0200	1944859	2371935	2785819	3319183
0.0225	0.0225	1728763	2108387	2476283	2950385
0.0250	0.0250	1555887	1897548	2228655	2655346

Population size 1000000
Number of cases detected (X) 2

Prevalence	Adjusted prevalence[b]	Required confidence level 90.0%	95.0%	97.5%	99.0%
0.0025	0.0025	21289270	25183181	28898794	33623655
0.0050	0.0050	10644635	12591590	14449397	16811828
0.0075	0.0075	7096423	8394394	9632931	11207885
0.0100	0.0100	5322318	6295795	7224698	8405914
0.0125	0.0125	4257854	5036636	5779759	6724731
0.0150	0.0150	3548212	4197197	4816466	5603943
0.0175	0.0175	3041324	3597597	4128399	4803379
0.0200	0.0200	2661159	3147898	3612349	4202957
0.0225	0.0225	2365474	2798131	3210977	3735962
0.0250	0.0250	2128927	2518318	2889879	3362366

Population size 1000000
Number of cases detected (X) 3

Prevalence	Adjusted prevalence[b]	Required confidence level 90.0%	95.0%	97.5%	99.0%
0.0025	0.0025	26723137	31014642	35069097	40180457
0.0050	0.0050	13361569	15507321	17534549	20090229
0.0075	0.0075	8907712	10338214	11689699	13393486
0.0100	0.0100	6680784	7753661	8767274	10045114
0.0125	0.0125	5344627	6202928	7013819	8036091
0.0150	0.0150	4453856	5169107	5844850	6696743
0.0175	0.0175	3817591	4430663	5009871	5740065
0.0200	0.0200	3340392	3876830	4383637	5022557
0.0225	0.0225	2969237	3446071	3896566	4464495
0.0250	0.0250	2672314	3101464	3506910	4018046

Table 3, Appendix 2. Summary table of point targets for several different population sizes and scenarios.

Target points	0 cases 95% confidence		1 case 95% confidence		2 cases 95% confidence	
Population size	***DP 1/M**	**DP 1/100,000**	**DP 1/M**	**DP 1/100,000**	**DP 1/M**	**DP 1/100,000**
> 1,000,000	2,995,730	299,573	4,743,870	474,387	6,295,795	629,580
800,000	2,396,584	239,658	3,795,096	379,510	5,036,636	503,664
600,000	1,797,438	179,744	2,846,322	284,632	3,777,477	377,748
400,000	1,198,292	119,829	1,897,548	189,755	2,518,318	251,832
200,000	599,146	59,915	948,774	94,877	1,259,159	125,916
100,000	299,573	29,957	474,387	47,439	629,579	62,958
50,000	149,787	14,979	237,193	23,719	314,789	31,479

*DP is the maximum possible prevalence or “design prevalence”

Table 4, Appendix 2. High intensity production point value table (Table 19 from BSurvE)

Table 19. v j,t: Ratio of detectable infected to uninfected animals (g j,t/d j,t)
that would exit via stream j at age t. These values are used as points associated with
the value of testing an animal.
See Figure 16, Resource Allocation Graphs worksheet.)

Age (years)	Surveillance stream			
	Healthy slaughter	Fallen stock	Casualty slaughter	Clinical suspect
0	0.00	0.00	0.00	0.0
1	0.01	0.18	0.36	265.0
2	0.04	0.18	0.31	206.0
3	0.19	0.38	0.58	303.4
4	0.26	0.98	1.73	900.2
5	0.22	1.01	1.84	828.9
6	0.15	0.72	1.32	514.4
7	0.10	0.46	0.83	281.3
8	0.07	0.45	0.85	266.7
9	0.05	0.21	0.37	99.3
10	0.04	0.21	0.38	95.5
11	0.02	0.08	0.14	28.9
12	0.02	0.11	0.20	40.4
13	0.00	0.02	0.05	10.7

Table 3, Appendix 2. Moderate intensity production point value table (Table 19 from BSurvE)

Age (years)	Surveillance stream			
	Healthy slaughter	Fallen stock	Casualty slaughter	Clinical suspect
0	0.00	0.00	0.00	0.0
1	0.01	0.29	0.57	420.0
2	0.05	0.33	0.63	440.0
3	0.19	0.44	0.71	393.9
4	0.27	1.19	2.14	1147.7
5	0.22	1.11	2.05	934.6
6	0.15	0.80	1.47	578.7
7	0.10	0.53	0.98	337.6
8	0.07	0.45	0.85	266.7
9	0.05	0.35	0.67	187.5
10	0.04	0.15	0.27	65.5
11	0.02	0.11	0.19	43.8
12	0.02	0.07	0.12	23.1
13	0.00	0.03	0.05	10.7

Table 4, Appendix 2. Low intensity production point value table (Table 19 from BSurvE)

Age (years)	Surveillance stream			
	Healthy slaughter	Fallen stock	Casualty slaughter	Clinical suspect
0	0.00	0.00	0.00	0.0
1	0.02	0.45	0.89	660.0
2	0.06	0.62	1.20	870.0
3	0.20	0.61	1.03	637.7
4	0.28	1.36	2.48	1350.2
5	0.26	1.91	3.63	1725.2
6	0.16	1.02	1.92	771.5
7	0.11	0.83	1.58	562.6
8	0.10	1.25	2.45	800.0
9	0.07	0.73	1.42	412.5
10	0.04	0.17	0.31	75.8
11	0.02	0.12	0.22	50.0
12	0.02	0.06	0.10	19.3
13	0.00	0.02	0.05	10.7